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WILLIAM PETIT TROWBRIDGE.

Died August 12, 1892.

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THE

# SCHOOL OF MINES QUARTERLY.

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## In Memoriam.

### WILLIAM PETIT TROWBRIDGE.

BY F. R. HUTTON, C.E., PH.D.

PROFESSOR WILLIAM P. TROWBRIDGE was at the head of the Department of Engineering in the School of Mines of Columbia College from May 1877 till his sudden death on August 12, 1892.

He was born at "Strawberry Hill," near Birmingham, Oakland Co., Michigan, May 25, 1828. He was therefore sixty-four years old at the time of his death. At the age of sixteen he was appointed a cadet in the United States Military Academy at West Point in an entering class of eighty-five, whence he graduated in 1848 at the head of his class. During his last year at the Academy when only nineteen years old he acted as Assistant Professor of Chemistry, the exigencies of the field service in the Mexican War calling for the attendance there of all available graduates. He entered the Engineer Corps by virtue of his standing, with the rank of second lieutenant, and was ordered back to his Academy as assistant in the Astronomical Observatory under Prof. Bartlett of the Department of Philosophy, serving for two years till 1850. This experience fitted him for duty on the work of the United States Coast Survey, to which at his own request he was subsequently ordered. Here he was assistant to Professor A. D. Bache



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working upon the primary triangulation of the coast of Maine, which in 1852 was placed in his charge. The period from 1851 to 1856 was entirely devoted to survey work, partly along the Appomattox River below Petersburg and the James River below Richmond in Virginia, and partly along the Pacific slope. The work upon the rivers was principally with a view to the improvement of their navigation, and he pointed out the advantage of the cut-off at Farrar's Island, which was actually carried out during the Civil War by the army, and was then and has been since known as the Dutch Gap Canal, shortening the distance for vessels by seven miles. The work on the Pacific slope (1853–6) was tidal and magnetic as well as geodetic, and covered the space between San Diego and Puget Sound, a length of over 1300 miles. The tidal gauges established by Lieut. Trowbridge recorded the earthquake waves emanating from Simoda, Japan, Dec. 23, 1854, while information of the occurrence reached this country *via* India two months after the probable nature of the disturbance had been reported. The waves had a length of 210 miles and travelled 355 miles per hour. He was engaged at this work for three years and often spoke of the pleasant memories which he retained of those then remote districts.

In 1856 he resigned his first lieutenancy (won in 1854) to accept the chair of Mathematics in the University of Michigan, remaining only a year, however, to return by the solicitation of Professor Bache to the Coast Survey to act as his permanent scientific secretary, and to reside in Washington, D. C. He held this office from 1857 to 1862. During this period he devoted himself to preparing for publication the results of the exploration of the Gulf stream; in 1860 he went to Key West to establish a permanent observatory for the automatic registration of magnetic variations (the first in this country); in 1861, at the breaking out of the war, he was summoned by his old chief, Gen. Totten, as a civilian, to loyal service anew, being assigned the duty of preparing minute descriptions of the harbors, inlets, and rivers of the Southern coast from Delaware Bay to Galveston, and in 1862 the hydrographic survey of Narragansett Bay, R. I., was entrusted to him to determine its suitability as a Navy Yard Station. The survey resulted in the abandonment of the project.

During the remainder of the war, he had charge of the branch office of the War Department in New York City, acting as agent

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in the supply of material for use in the field, and as constructor of local fortification. This was a heavy responsibility in its financial relations to contractors supplying war material, involving an aggregate of several millions of dollars, and exacted the most scrupulous honesty and integrity for its faithful discharge, and in the duty of the construction of forts some difficulties had to be overcome. The principal works were the fort at Willett's Point and on Governor's Island and the repairs of Fort Schuyler. The Willett's Point fort was to be the largest seacoast battery on the Atlantic, and was to carry 100 13-inch guns in three tiers of casemates and in barbette. Of the masterly manner in which the first-mentioned of these works was executed General H. L. Abbot, the officer for many years in command of the fort, spoke as follows: "The work was done in great haste, to close the harbor of New York against raids from war-vessels of the Confederacy, or of their possible foreign allies. The site presented peculiar difficulties, requiring a coffer-dam and an unusual system of sub-drainage to preserve the foundations. A steep bluff in the rear contracted the space and greatly increased the difficulty of handling the materials. A wharf over 450 feet long had to be built, with all the needful shops and buildings. By special devices, showing much skill and ingenuity Professor Trowbridge overcame these difficulties, and not only made astonishing progress with the work, but left it one of the finest specimens of granite masonry to be seen in any of our fortifications."

After the close of the war in 1865, Professor Trowbridge became the Vice-President of the Novelty Iron Works in this city, of which Mr. Horatio Allen was the President. He remained in this relation till 1871, and it was during this period that he became so well and favorably known as a mechanical engineer. Mr. Allen had been the first generally to introduce the locomotive engine from England in 1829, and had himself run the first imported engine for the Delaware and Hudson Canal Company. He had designed the early American locomotives run in South Carolina, and the Novelty Works had designed and constructed the first transatlantic steamers, of the Collins Line. During the war, in common with the rest of the marine shops, there had been abundant business in construction and alteration of vessels and machinery. It was during Professor Trowbridge's connection with the Novelty Iron Works that those experiments were undertaken

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to determine the consumption of water for horse-power in engines at different points of cut-off of the stroke of the cylinder, which have become historic, and have served as starting point and standard for much of the more recent work in this direction. They also pointed out the advantages which would follow from the use of a higher speed of piston in the engine than had been usual in the designs up to that time. These experiments led the practice of many engine builders for years, until the rise of the type which electric lighting practice has called into use. But the business changes following the lessened amount of marine activity in construction after the war induced the closure of the works, and the disposal of its tools and patterns and drawings. Many of these latter illustrating the practice of the Pacific Mail Steamship engineers for many years, Professor Trowbridge was able to secure for the Sheffield-Scientific School of Yale College to which he was called by the corporation in 1871 as the professor of dynamic engineering. He was very active in the building up of his new department, and in the planning and construction of the New Sheffield Hall, in which the engineering instruction was given. He remained in this field until in May, 1877, he was called by the Trustees of the College to the position he held till his death.

It will be recalled by the earlier graduates of the School of Mines that the professorship of Civil and Mining Engineering had been filled from the beginning of the history of the School until this date by a very able mathematician and an ex-army officer who had received his education both at West Point and at the Ecole des Mines at Paris. But with all his attainments and ability there had been a growing dissatisfaction with his methods, which had found a culminating expression at a meeting of the Alumni held in the winter of 1876–77, and which was followed in April of that year by the presentation of a printed report by a committee of the Trustees, definitely abolishing the former chair and establishing the new chair of engineering, and an adjunct professorship of practical mining and an instructorship in mechanical engineering. When the election was held in May, Professor Trowbridge was chosen to the new chair, and the other positions were filled by Professor H. S. Monroe and the writer respectively. The department was immediately reorganized on the new basis when the new officers began their duties in the autumn of that year, and the history of the department from that time has been the history of

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its chief. There was added to the courses as they existed in 1877, successively courses in thermo-dynamics, dynamics of machinery, and water-supply engineering, while the existing courses in hydraulics, braced structures, machines and motors were developed, sub-divided, and built upon out of all resemblance to their old standards as the succeeding generations of classes made possible the elevation of requirement. Under the progressive planning of Professor Trowbridge, the old area of the third floor of the Fiftieth Street building was successively outgrown, first from 1879 to 1883 to fill as additional space the second floor of the old college building, and later the new floor for engineering in the Fourth Avenue building was added and for the last few years even this space was too cramped for efficient work. When he came, the school gave only the degrees of mining engineer and civil engineer, and the latter was regarded as subsidiary.

During the early years of his incumbency, the members taking this course began largely to increase, and, later, courses for the degree of Sanitary Engineer and Electrical Engineer were added to the list of engineering degrees; and had there been room in the restricted site of the School of Mines, mechanical engineering, which had his warm support, would have had also a place. He was made a member of the University Council of the College when the new organization was effected, in 1891, and was a favorite choice upon important committee labor, where his sound judgment and judicious counsel made him a most valuable member. He also gave much careful thought to the subject of training of graduates in engineering for further and higher competency. There were long and frequent conferences with the writer upon a plan very dear to his heart, of organizing a special department for higher specialization, which should be equipped with professional apparatus and machinery, and in which the instruction should be given by distinguished specialist practitioners. This plan reached the stage of an official letter to President Barnard of the College, and later to President Low, but has had to rest in abeyance to make room for more urgent matters.

Of Professor Trowbridge's work as a teacher of undergraduates, it is difficult to speak without at the same time considering his traits as a man. A more unselfish and self-sacrificing person is rarely met, and this would appear to be the keynote of that success which was accorded to him, and which has made so strong a

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bond between him and so many of his old students. He was genial and familiar, and yet never undignified in his intercourse with them, and each felt that he could rely upon an affectionate personal interest if he wanted advice or help. The instructor who can thus command the affectionate respect of a class of young men of professional school age, finds an easy path of influence before him. There are many who feel that in the death of their former professor they have lost a firm and wise friend and counsellor.

In his relations as head of a large and important department of instruction, those who have been thus associated with him have only words of praise and affection. The position was a difficult and delicate one as concerned subordinate officers, but in every way he showed himself most considerate and without self-seeking narrowness.

He was married April 21, 1857, at Savannah, Ga., to Miss Lucy Parkman, one of the three surviving members of a large family which was lost in the steamer *Pulaski* in 1838. Of this marriage there were eight children. His wife, three sons and three daughters survive him. In his relations to his family as husband and father, those who have known them in intimacy will recall how he was the centre around whom the family circle grouped itself, and who was their prime dependence. His loss there is one from which the stranger pen must refrain to allude.

Prof. Trowbridge's two best known recent professional achievements were his design for the first cantilever bridge and his coil boiler. It was while he was at the Novelty Iron Works that he designed a cantilever bridge for the East River at Blackwell's Island, and urged the adoption of the cantilever system as the most available for spans beyond the practical limit of the single girder. A company was formed in 1869–70, of which Mr. Wm. Steinway was president, for the erection of the bridge according to the proposed plan; but the value of the cantilever system, so strongly urged then by Mr. Trowbridge, and so signally successful since that time in other places—as at Niagara Falls and at the Firth of Forth—was not publicly appreciated, and the panic of 1873 put an end for the time to all efforts to build the bridge. His coil boiler was thought out while he was at the Sheffield Scientific School, and was designed to incorporate the most advanced ideas of forced circulation of the water, automatic supply of feed-

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water from a magazine, and the self-feeding of its fuel. Exhaustive experiments and trials were kept up to develop the weak places in the design, and most satisfactory results were obtained as to the capacity of the boiler in small bulk and the reliability of the subsidiary apparatus. Its manufacture was turned over to a company, and the inventor was unable to pursue the matter further. Prof. Trowbridge had also given much thought to apparatus for deep-sea sounding, and felt very sanguine as to the applicability of electric devices for this object.

During his connection with the School of Mines, Professor Trowbridge retained his family residence in New Haven, where he remained only from Friday night to Monday morning early during the college terms. This plan gave him the freedom from all college calls when at home, and released him from demands from the home circle when in New York. He was a member of the Century Club, but spent much of his time in his study when the College did not call him there. But his Connecticut residence brought him many engagements. He was Adjutant-General of Connecticut from 1872 to 1876, under Gov. Ingersoll; from 1873 to 1878, Commissioner for building the Capitol at Hartford; from 1870 to 1876, Commissioner for building a bridge across the Quinnipiac River; from 1872 to 1878, Commissioner for establishing harbor lines at New Haven. He was also appointed by Gov. Cornell, of New York, one of three commissioners to examine the State Capitol at Albany, the other two being Mr. Geo. B. Post, the architect, and Prof. Babcock, of Cornell University.

He was author of *Heat and Heat-Engines* (1874); but on the exhaustion of the edition he had been too busy with his teaching-work to undertake its re-issue, and was engaged on this work when his hand was stilled by death. He had planned a series of four, which were to have been Heat, Light, Magnetism and Electricity as manifestations of energy. He was associate-editor with Dr. Barnard of *Johnson's Encyclopædia;* and wrote also for other standard publications. His college honors were an A.M. from Rochester University in 1856, and from Yale in 1870; Ph.D. from Princeton in 1880; and LL.D. from Trinity in 1883, and Michigan University in 1887. In 1880, under the broad plans of General Francis A. Walker for the Tenth Census, Professor Trowbridge was put at the head of the Department of Power and Machinery employed in Manufactures, and several notable monographs were issued in this subdivision under his solicitation and control.

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Professor Trowbridge was a member of the National Academy of Sciences, and presided at its sessions of 1882. He was a Vice-President of the American Society of Mechanical Engineers, and member of the other engineering societies at one time or another. He was very active in the New York Academy of Sciences, and a frequent contributor and occasional lecturer before it, and there were many other organizations which claimed a share of his broad-minded interest.

In fine, the School of Mines has had in Professor Trowbridge that rare combination of personal qualities of character with intellectual capacity and technical acquirement, which made him an almost ideal selection for the position which he was called upon to fill. With ability to appear before a broader public with credit, and appreciating the advantages which follow to an institution from such wider recognition of its professors, yet withal so modest and conscientious as never to be tempted to neglect a near duty because inconspicuous, his loss is made the more grievous by the very rarity of the union of these qualities in one person. The School of Mines has been privileged so long to rejoice in the relations which have now been ended by his death.

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## THE CLASSIFICATION OF ORE DEPOSITS.

By J. F. KEMP.

In the classification of ore deposits the same systematic arrangement is not to be expected, as in the grouping of plants, animals, or minerals. Ore deposits have not the underlying affinities and relationships of living organisms or of definite chemical compounds. The series of objects is too diverse and, in the nature of the case, the standards of appeal must be different. The subject is, however, one of great practical importance as well as of great scientific interest. A vocabulary of intelligible terms is indispensable for description and comparison, and, under our mining laws, often for valid titles, while as a vehicle for the spread of knowledge and reasonable conceptions regarding these phenomena, its importance cannot be overestimated.

All schemes of classification rest on these principles: form, ori-

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